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SANITARY ENGINEERING ASPECTS OF ATMOSPHERIC POLLUTION

by Louis C. McCabe

SANITARY ENGINEERING
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SANITARY ENGINEERING ASPECTS OF ATMOSPHERIC POLLUTION[1]

Louis C. McCabe[2]

The interests of the various technical organizations in atmospheric pollution have become somewhat better defined during the past two or three years than they have been heretofore. We find investigators from the physical and biological sciences, engineering and, to a limited extent, the medical professions, working on almost all aspects of atmospheric pollution. Several of the technical societies are active in sponsoring investigations or in stimulating research in their various fields of interest. Following is a partial list of these organizations: Air Pollution Control Association; American Chemical Society, Committee on Air Pollution; American Medical Society; American Meteorological Society; American Petroleum Institute; ASME Committee on Air Pollution Controls; ASTM Committee D-22, "Methods of Atmospheric Sampling and Analysis"; Bituminous Coal Research, Inc.; Coal Producers Committee for Smoke Abatement; Manufacturing Chemists Association; Midwestern Air Pollution Prevention Association; and The Western Oil and Gas Association.

There are more than 40 universities and other laboratories engaged in research on various phases of atmospheric pollution and the number is constantly increasing. Many industries are conducting investigations of special interest which are finding their way into the professional and trade journals.

When smoke prevention and fly ash were the principal concern of smoke abatement officials, the solution to atmospheric pollution was relatively simple. The complex industrial processes that have developed in recent years have brought far more difficult situations. The satisfactory solution of these problems is not easily attained and the nontechnical citizen is generally unable to appreciate the difficulty in determining the source of pollution and in obtaining correction once the problem is understood. Careful research is very time consuming. There is no escaping the drudgery that is necessary if a proper solution is to be found.

Certainly the trained sanitary engineer has a place in the ultimate solution of this problem which has come with the growth of our industrial communities. The techniques and concepts employed in the analysis of waterborne waste or in the study of the atmosphere of the enclosed working place are essentially those required in atmospheric pollution study. The sanitary engineer already has had extensive experience with many of the air pollution problems, notably odors and waste disposal.

Disagreeable odors are encountered in many activities of an urban area, and no aspect of air pollution receives such an immediate response from the public. Location of the source of the objectionable odor is usually a relatively

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simple matter. But its control frequently may be accomplished only after extensive redesigning and construction of plant or equipment. Nevertheless, considerable progress has been made in reducing local odor nuisances.

Fish meal, an important byproduct of the fish packing industry, is prepared by grinding and dehydrating scraps and entrails from which the oil has been extracted. A few years ago oil-fired dehydrators were in use which permitted flame to come in contact with the wet fish meal. The odors produced were not only obnoxious to the community, but they impaired the efficiency of the personnel working in the plant. State inspectors sometimes have closed packing plants because the odors from the dehydrators made it impossible to determine by sense of smell the freshness of fish being processed.

In early attempts to eliminate the odors, the gases from the dryers were taken through a gas-fired incinerator in which a minimum temperature of 1400^0 F. was maintained. Although incineration was effective it was so expensive that it was discontinued. Low temperature dehydration has since come into general use. In the drying system now in use the air is introduced at 500^0 F. and the meal is drawn out by a blower unit only when the desired dryness is attained, normally at a product temperature of 160^0 to 175^0 F.

The need for odor control in those industries which process dead animals may be greater than in the packing plants which are preparing food for human consumption. Some of these rendering plants in Los Angeles have used Venturi jet condensers successfully but most of them rely on incineration to abate odors. Cooker discharges are either conducted into the fire boxes of the boilers or into auxiliary odor burners. While these methods reduce odors in the surrounding residential areas odors may persist in the vicinity of the plant. Where this condition exists it may be traced to malfunction of the incinerator unit, or overloading or leakage in the duct system. Lack of cleanliness in maintenance also may account for odors around rendering plants.

Odors from coffee roasting may cause complaints from those in the vicinity of such installations. Chaff and oils from the coffee bean are partially burned during the roasting process and released to the air. Incinerators costing $1500 to $3000 which burn these effluents effectively have been developed, as in fish meal drying. A new low temperature coffee roaster has been developed which does not produce the quantity of odor which is characteristic of high temperature roasting.

The greatest source of malodors in oil refineries are mercaptans which contain sulfur and are commonly derived from high sulfur crudes. All the sulfur in these crudes is not in this form, but certain refinery processes such as thermal cracking convert them to mercaptans.

Mercaptans may be removed from petroleum products by treating in a variety of processes practically all of which utilize caustic action. This presents a problem of disposing of the mercaptans or the spent caustic solution containing them. A limited market exists for mercaptans as a warning agent in natural gas. Mercaptans also are intermediate chemicals in the organic synthesis of amino acids used in cattle feed.

In gasoline treating, mercaptans are converted into disulphides which are not particularly obnoxious. The disulphides are left in the gasoline in some processes and in others are removed and burned in a refinery furnace or blended with fuel oils. The odors from the finished products are not obnoxious.

Paints and varnish plants may discharge highly irritating substances such as acrolein, other aldehydes, and fatty acids from their processes. The incineration of paint and varnish cooker discharges is the surest and most

efficient method of reducing the offensive odors which they produce. The common practice is to install blowers to force vapors from the cooking kettles through a high velocity Venturi throat which minimizes flashbacks, one of the principal drawbacks to incineration. Incineration is usually more expensive than scrubbing but complete combustion will convert the most objectionable odors into carbon dioxide and water.

Incineration of domestic household waste and garbage is generally not a sure means of eliminating odors in air pollution. Poor design, intermittent operation and the character of the waste material are responsible for unsatisfactory operation. Some cities collect all garbage and combustible waste to dispose of them in municipal incinerators or sanitary fill operations. A few still dispose of edible refuse by feeding to animals. Garbage disposal units are becoming more widely used. However, it appears that the home incinerator and the apartment incinerator will be used for a long time because of its economy. In all probability it will continue to be a major source of air pollution.

It is now generally recognized that hydrocarbons in the air may be oxidized to produce compounds which will damage growing crops and cause eye irritation. This is particularly important in the Los Angeles area where the smog conditions are characterized by a polluted air mass which causes a reduction in visibility as well as crop damage and eye irritation. The smog occurs almost invariably under conditions of 60 percent relative humidity or lower and is accompanied by unusually high concentrations of ozone.

During oxidation of hydrocarbons a series of products are formed, with formaldehydes and acids as the end products.

It has been shown that oil fractions acquire weed-killing properties when exposed to the action of sunlight and oxygen. Saturated as well as unsaturated hydrocarbons are thereby oxidized yielding peroxides in their conversion products, aldehydes and acids.

While Los Angeles most commonly experiences air pollution of this character because of its meteorological and topographic characteristics, similar fumigations probably are experienced infrequently by Houston, Detroit, Metropolitan New York, Washington, and other cities. Certainly the latter report eye irritation occasionally, but there are no reports of crop damage.

Opinions differ about the contribution of the automobile to atmospheric pollution, but several studies are now available which show material amounts of chemicals from this source going into the air. Benoliel and Magill recently have studied the composition of exhaust gases from automobile engines under simulated operating conditions and from operating vehicles. From these studies they have estimated the amounts of chemicals from this source going to the air in Los Angeles. Based on the consumption of 10,500 tons per day of automobile gasoline, and calculated on the basis of 40 percent fuel used under road speed conditions, 40 percent under acceleration-deceleration, and 20 percent at idling speed, they report the following amount of chemicals from this source going to the air in Los Angeles daily (Table 1).

TABLE I

Analysis of Automobile Exhaust
Daily Emissions to Atmosphere in Los Angeles

Aldehydes	30 tons	Acids	3 tons
Ammonia	4 "	Organic Compounds	350 "
Hydrogen Oxides	40 "	Sulfur Oxides	30 "

The emission of organic materials and oxides of nitrogen varies considerably with engine operating conditions, but they represent approximately 3-1/2 percent of the gasoline consumed.

A great many plants which now contribute to air pollution were originally located in isolated areas built at a time when there was plenty of open country available for discharge of contaminants. Some of these that once set quietly in areas of small population or were located where smoke, fumes or waste could do no considerable harm are now near or in the heart of populous communities, competing with other industries for the good will of the employees and the community and subject to the increasing demand for clean air. This problem has led city planning authorities to give more careful thought to the zoning of cities and Detroit is attempting to rehabilitate and rezone old areas of the city. Certain parts of the nearby downtown area would be limited to service types of industry, and the heavier industries which produce dust, fumes and smoke would be assigned areas on the outskirts of the city, downwind from the residential and business areas, as far as possible. Residential facilities would be prohibited from entering or encroaching on the heavy industrial zones.

The demand for instruments and methods for accurate determination of airborne dust, gases and vapors has been met to some extent in the last four or five years, although there are some important instruments still in the development stage. Considerable headway has been made also in the development of the equipment for the control of dust, smoke and fumes. Electrostatic precipitators have been installed for the first time on open hearth steel furnaces and on the electric steel furnace. Glass fiber bags and orlon fiber bags have been developed to operate at higher temperatures to collect dust from lead and zinc and other smelting operations. Catalytic units for the combustion of hydrocarbons from paint spray, lacquering and other industrial processes producing flammable fumes and vapors have been perfected and installed. The Venturi scrubber has been developed and installed on various chemical and metallurgical processes. Combustion equipment has been further perfected and provided with controls which permit smokeless combustion of fuels of all types. Operating cycles have been correlated with meteorological conditions in some areas to reduce maximum concentrations of atmospheric pollution.

Perhaps more important than these developments is the interest of trained engineers and scientists in the broad aspects of atmospheric pollution. Many cities and some of the states have recognized the technical character of the atmospheric pollution problem and have provided more funds than ever before for work in this field. We find more trained engineers and scientists employed in research and enforcement capacities. This is an important step in the control of atmospheric pollution and because of the many differences in meteorology, topography, density of population, and industrial activity each city must establish its own standards. The enforcement of atmospheric pollution regulations is a local problem but it must be done only after the most careful technical evaluation.

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